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518 Rec'd PCT/PTO 04 SEP 2001

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Electric Direct Current Machines

The invention relates to an electrical direct current machine including a rotor, which is rotatably mounted in a housing and has a plurality of electromagnets spaced from the axis of rotation with a respective coil winding on a coil core carrying one or more electrical conductors, the ends of the electrical conductors constituting the coil being electrically conductively connected to respective associated contact elements, which together constitute a first commutator, with a respective contact surface, pressed against which are sliding contacts, which are connectable to at least one direct current source or at least one direct current consumer, and including pole surfaces of permanent magnets with alternating polarity in the peripheral direction, which are arranged at uniform angular spacings on the inner surface of the housing end walls and are opposed to the end surfaces of the coil cores, whereby each coil core together with the associated coil winding constitutes a separately manufactured electromagnet unit, which is mounted in a hub carrier rotationally fixedly connected to the shaft of the rotor, the pole surfaces of the permanent magnets have an extent in the peripheral direction which overlaps with a plurality of opposed coil cores and the two sliding contacts of the commutator associated with a respective radially outwardly situated permanent magnet extends so far in the peripheral direction that they overlap with about half of the contact elements associated with a pole surface of a permanent magnet and whereby provided on each pair of sliding contacts connected to the direct current source or the direct current consumer, offset in the peripheral direction, there is a further pair of sliding contacts connected in the reverse polarity to the direct current source(s) or direct current consumer and further double pairs of commutator sliding

contacts, constituting a second commutator, are provided to be connectable to the direct current source(s) or direct current consumer with successively reversed polarity.

Such a direct current machine (DE 19721215 A1) has been developed by the applicant in a further embodiment of an older direct current machine (DE 19620291 C2). In the known direct current machines, the sliding contacts, which are constructed in the form of carbon brushes resiliently pressed parallel to the axis of rotation of the rotor, are arranged in opposing covers at the ends of the housing and are pressed on the end edges directed towards the end walls of the radial sections of the conductive strips constituting the winding of the electromagnet units and which thus constitute overall the two commutators.

It has transpired in tests that this construction of the known direct current machine results in the desired advantages with respect to the older direct current machine. However, its construction is expensive due to the construction of the two commutators on opposite sides of the rotor and the arrangement parallel to the axis of the sliding contacts constructed in the form of carbon brushes.

It is the object of the invention to develop the known direct current machine so that it produces an even higher output with a simplified construction.

Starting from a direct current machine of the type referred to above, this object is solved in accordance with the invention if the first and second commutators are so arranged on the rotor shaft in the axial direction of the rotor and axially offset from one another that their contact surfaces associated with the sliding contact are situated, directed radially outwards, on cylindrical envelope surfaces

and if the breadth of the sliding contacts measured in the axial direction is so selected that they are pressed simultaneously against the contact surfaces, adjacent in the axial direction, of both commutators. Instead of separate sliding contacts for each of the two commutators, sliding contacts are provided in this case which are usable in common for the two commutators by reason of their breadth, i.e. the number of the (widened) sliding contacts is thus halved.

The construction is preferably such that the contact surfaces of both commutators are connected to coil windings offset from one another in the peripheral direction of the rotor, of the electromagnet units of the rotor. Direct current is thus supplied to or led away from two groups of electromagnet units offset from one another in the peripheral direction simultaneously via each sliding contact.

The offset of the contact surfaces of the contact elements of the two commutators in the peripheral direction is selected to be at least the size of the angular spacing between two successive permanent magnets in the peripheral direction in the housing.

The two commutators are conveniently arranged on the rotor shaft outside the end surfaces of the housing accommodating the rotor. It is thus possible to shield the magnetic and electromagnetic portion of the motor from the commutators and thus to avoid negative effects of electromagnetic fields in the region of the commutators.

With the arrangement of the commutators on the end walls outside the housing, it is recommended that the two commutators are arranged in a separate cover

provided on the end wall of the housing, whereby the mounting for the sliding contacts can then also be provided in or on the cover. The commutators and sliding contacts are thus protected against environmental influences and are on the other hand easily accessible for maintenance purposes.

If necessary, the space defined in the housing by the cover and the associated end wall can also be ventilated by forming a suitable ventilation opening in the cover, through which dust from the sliding contacts (carbon brushes) and/or the commutators contact surfaces can be discharged. A cooling effect may also be achieved which may be so produced by construction of the hub region of the commutators in the form of fan wheels or by an additional fan wheel within the cover that the optimum temperatures for the commutator function prevail within the cover.

The invention will be described in more detail in the following description of two exemplary embodiments in conjunction with the drawings, in which:

Fig. 1 is a central longitudinal sectional view of a schematically illustrated direct current machine in accordance with the invention;

Fig. 2 is a view of the commutator end surface of the direct current machine with the cover removed, seen in the direction of the arrow 2 in Fig. 1; and

Fig. 3 is a view corresponding to the view of Fig. 2 of a second exemplary embodiment of a direct current machine in accordance with the invention.

A direct current machine in accordance with the invention, which is designated 10 in its entirety and may be used as a motor and as a generator, is shown schematically in the drawings. The machine 10 has in this specific case a housing 12, which is relatively short in the axial direction and comprises two disc-like housing end walls 14a, 14b of relatively large diameter and the actual housing peripheral wall 16, which is practically converted to a cylindrical ring of relatively small length. Housing end walls 14, 14b and housing peripheral wall 16 are demountably connected together by housing or other fastening means, not shown.

Provided centrally in the end walls 14a, 14b are respective through openings 15a, 15b, which are constructed in their region in the interior of the housing to form bearing mounts 20 of enlarged diameter for radial bearings 22, in which a shaft 24, which passes through the through openings 15a, 15b, is rotatably mounted. This shaft 24 carries the rotor 26 which is rotationally fixedly mounted on it. Arranged on the inner end faces of the housing end walls 14a, 14b at uniform angular spacings and positioned as far radially outwardly as possible are permanent magnets 28 on the same radius with respect to the central axis of the housing. Thus, for instance, the end walls 14a, 14b may each carry a total of 12 permanent magnets 28, which have alternating polarity in the peripheral direction.

The rotor 26 has a plurality of electromagnet units 30, which are primarily constructed in the form of separate individual components, each of which has a coil core 32 constructed in the form of a disc of soft-magnetic material, wound over which is a coil winding with a plurality of windings of a metal wire, which

is conveniently manufactured from a highly electrically conductive copper alloy. The metal wire is insulated in the region constituting the winding on the coil core in the conventional manner, e.g. by a non-conductive lacquer, with respect to the coil core and adjacent units 30. The coil core 32 is for its part constructed from packed transformer plates insulated from one another in order to substantially suppress eddy currents. The ends, not illustrated, of the metal wire forming the coil winding 34 of each electromagnet unit 30 extend radially inwardly in the direction towards the shaft and lead through a hub carrier supporting the electromagnet units to two commutators 18a, 18b arranged axially adjacent one another on the left-hand end of the shaft 24 which passes out through the end wall 14b. The connection of the contact elements of the commutators with two coils 34 of electromagnet units 30 through the hub carrier 38 is indicated in chain lines in Fig. 1. The mounting of the electromagnet units 30 on the hub carrier is effected in the illustrated case by, on the one hand, annular discs 36 of electrically conductive material, which support the units 30 on opposite sides and are secured in a suitable manner to the hub carrier 38.

The commutators 18a, 18b are constituted by a number, corresponding to the number of the ends of the metal wires constituting the coil windings 34, of successive contact elements 40 in the peripheral direction, which are electrically insulated from one another and are arranged concentrically with the shaft 24 and whose radially outer boundary surfaces, which lie on a common cylindrical envelope surface, constitute contact surfaces 34 for sliding contacts 42, 50, connected to which is a direct current source or a direct current consumer, which is not shown in the drawings. The sliding contacts 42, 50 are constituted in this special case in a manner known per se by electrically conductive carbon

brushes, which are arranged so as to be movable in the radial direction, in a manner illustrated in Fig. 2, in mounts 46, which may be secured to the outer surface of the end walls 14b of the housing 12. The carbon brushes are pressed into engagement with the contact surfaces 44 by springs 48 under a pressure biasing force. The contact elements 40 are connected in a manner which is not illustrated to a respective end section of the metal wire constituting the coil windings 34 of the associated electromagnet unit 30, groups of electromagnet units offset from one another in the peripheral direction being connected alternately to the commutators 18a and 18b.

It may be seen in Fig. 1 that the width, measured in the axial direction, of the carbon brushes constituting the sliding contacts 42, 50 is so selected that each carbon brush is pressed simultaneously onto associated contact surfaces 44 of adjacent contact elements 40 of the two commutators 18a, 18b. By virtue of an angular offset of the commutators 18a, 18b in the peripheral direction, it is thus possible to electrically connect two groups, offset from one another in the peripheral direction, of electromagnet units to the direct current source or a direct current consumer to a respective sliding contact or a carbon brush. It is thus possible to halve the number of the sliding contacts with respect to a construction in which separate sliding contacts are associated with each commutator. The concept explained above of reducing the number of sliding contacts may be further expanded within the context of the inventive concept if a third commutator is added to the two commutators 18a, 18b, the contact elements of which are again offset from the two first commutators in the peripheral direction and are electrically connected to groups of electromagnet units 30. In this case, a sliding contact (carbon brush), which is further broadened in the axial direction, is pressed simultaneously against the contact

surfaces of the contact elements of all three commutators. The number of the necessary sliding contacts is thus reduced to one third.

The commutators 18a, 18b arranged on the end of the shaft 24 passing out of the end wall 14b of the housing are conveniently covered by a cover 52, which is indicated only schematically in Fig. 1 and encloses the entire commutator arrangement in a space defined between the cover 52 and the outer end surface of the end wall 14b. In order to render access to the commutator arrangement possible, if, for instance, carbon brushes 42 or 50 must be replaced as a result of wear, the cover 52 is conveniently constructed so as to be fastenable to the end wall 14b in a readily removable manner.

If the commutator arrangement is to be ventilated for the purpose of cooling or for blowing out dust, corresponding ventilation holes (not shown) can also be provided in the cover, whereby forced ventilation may also be produced by further features, which are also not illustrated in the drawings, for instance the arrangement of a fan wheel within the cover rotating with the shaft 24.

An exemplary embodiment of the direct current machine in accordance with the invention, which is simplified with respect to the number of the sliding contacts 42, 50 pressed against the contact surfaces 44 of the contact elements 40, is illustrated in Fig. 3, which corresponds to the view of Fig. 2. Instead of eight mountings 46 for four pairs of contacts in the exemplary embodiment of Fig. 2, only two mountings 46 are provided in this case for one pair of contacts. In order nevertheless to control all the electromagnet units offset in the peripheral direction with electric current of the respective necessary polarity, the contact elements 40 in Fig. 3 are electrically connected together in the manner

illustrated by the lines 56, only the electrical connection of four contact elements of the commutator being shown in the drawings. The electrical connections of the adjacent contact elements 40 in the peripheral direction are not shown so as to provide a better overall view, i.e. they are to be added in the mind of the reader. It will be clear that in this exemplary embodiment the mountings 46, which are illustrated only in chain lines in Fig. 3, can be omitted as a result of the illustrated electrical connecting together of contact elements 40.